Stress and Blood Pressure in Dementia Caregivers: The Moderator Role of Mindfulness

Vara-García, Carlos ; Romero-Moreno, Rosa ; Márquez-González, María ; Mausbach, Brent T ; von Känel, Roland ; Gallego-Alberto, Laura ; Olmos, Ricardo ; Losada, Andrés

Abstract: OBJECTIVE: Dementia caregiving has been described as a chronically stressful situation with adverse cardiovascular effects. Psychological resources such as mindfulness may reduce the impact of stress on caregivers' cardiovascular health. The objective of this study was to analyze the moderating effect of trait mindfulness on the relationship between frequency of disruptive behaviors of the care recipient and blood pressure (BP) in dementia caregivers. METHOD: Participants were 110 dementia family caregivers. Two hierarchical regressions (for systolic and diastolic BP) were conducted to analyze whether mindfulness moderates the relationship between disruptive behaviors and BP after controlling for known predictors of cardiovascular outcomes. RESULTS: A significant moderator effect of mindfulness was found between the frequency of disruptive behaviors and diastolic BP (= -.195, p < .05). Among those caregivers reporting low levels of mindfulness, the relationship between frequency of disruptive behaviors and diastolic BP was relatively stronger than among those reporting high mindfulness levels. CONCLUSIONS: The results suggest that a high level of trait mindfulness may have protective effect on BP when caregivers face high levels of stress. CLINICAL IMPLICATIONS: Mindfulness seems to be an important variable with potential for buffering the effects of caregiving stressors on caregivers' blood pressure.

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Title: Stress and blood pressure in dementia caregivers: the moderator role of mindfulness

Running Head: Mindfulness and blood pressure in caregivers

Carlos Vara-García, M.A.[1], Rosa Romero-Moreno, Ph.D.[1], María Márquez-González Ph.D.[2], Brent T. Mausbach, Ph.D.[3], Roland von Känel M.D.[4], Laura Gallego-Alberto, M.A.[2], Ricardo Olmos, Ph.D.[2], Andrés Losada, Ph.D.[1]

1- Universidad Rey Juan Carlos, Department of Psychology. Alcorcón, Spain.
2- Universidad Autónoma de Madrid, Department of Biological and Health Psychology. Madrid, Spain.
3- University of California, San Diego, Department of Psychiatry. La Jolla, CA, USA.
4- Department of Consultation-Liaison, Psychiatry and Psychosomatic Medicine, University Hospital Zürich. Zürich, Switzerland.

Address for correspondence: Carlos Vara García, Universidad Rey Juan Carlos, Campus de Ciencias de la Salud, Departamento de Medicina y Cirugía, Psicología, Medicina Preventiva y Salud Pública e Inmunología Microbiología Médica y Enfermería y Estomatología, Facultad de Ciencias de la Salud , Av. de Atenas, S/N, 28922 Alcorcón, Madrid, Spain. +34610281699. carlos.vara@urjc.es. ORCID: 0000-0002-5379-5770

ABSTRACT

Objective: Dementia caregiving has been described as a chronically stressful situation with adverse cardiovascular effects. Psychological resources such as mindfulness may reduce the impact of stress on caregivers' cardiovascular health. The objective of this study was to analyze the moderating effect of trait mindfulness on the relationship between frequency of disruptive behaviors of the care recipient and blood pressure (BP) in dementia caregivers. Method**:** Participants were 110 dementia family caregivers. Two hierarchical regressions (for systolic and diastolic BP) were conducted to analyze whether mindfulness moderates the relationship between disruptive behaviors and BP after controlling for known predictors of cardiovascular outcomes. Results**:** A significant moderator effect of mindfulness was found between the frequency of disruptive behaviors and diastolic BP (β = -.195, p < .05). Among those caregivers reporting low levels of mindfulness, the relationship between frequency of disruptive behaviors and diastolic BP was relatively stronger than among those reporting high mindfulness levels. Conclusions: The results suggest that a high level of trait mindfulness may have protective effect on BP when caregivers face high levels of stress. Clinical Implications: Mindfulness seems to be an important variable with potential for buffering the effects of caregiving stressors on caregivers' blood pressure.

Keywords: blood pressure; caregiving; dementia; disruptive behaviors; mindfulness.

INTRODUCTION

Elevated blood pressure (BP) is a major risk factor for cardiovascular diseases (Lawes, Vander Hoorn, & Rodgers, 2008). The association between a rise in BP and cardiovascular disease (CVD) risk appears to be linear, with every increase of 10mmHg in diastolic BP over 75 mmHg doubling risk of developing a CVD (Prospective Studies Collaboration, 2002). Because of the risk of various diseases attributable to elevated BP, it is estimated that between 1.6 and 5.0 years of life are lost due to the disease burden brought on by an elevated BP (Rapsomaniki et al., 2014).

Being a caregiver of a relative with dementia is a chronically stressful situation associated with an increased risk of developing CVD (Vitaliano, Zhang, & Scanlan, 2003; von Känel et al., 2008). Among caregivers, greater distress has been shown to confer significant risk for developing CVD over an 18-month follow-up (Mausbach, Patterson, Rabinowitz, Grant, & Schulz, 2007). Among the possible mechanisms by which caregivers develop CVD, rising BP appears to be one of the most likely candidates. In a six year study by Shaw and colleagues (Shaw et al., 1999), stressed dementia caregivers were found to develop hypertension significantly earlier than their non-caregiving peers. Another study found that the risk of hypertension onset is associated with both current and long-term caregiving, even after adjusting for demographic, socioeconomic, and health factors known to be associated with hypertension risk (Capistrant, Moon, & Glymour, 2012).

Although caregiving stress appears to be associated with increased CVD and hypertension risk, various stress and coping models suggest that this risk may depend upon the coping profile of the caregiver (Knight & Sayegh, 2010). Among these models, Lazarus and Folkman’s (1984) transactional model of stress and coping model views stress as a function of the individual's cognitive appraisal of events as threatening or potentially harmful to one's well-being (i.e., primary appraisal), and the individual's appraisal of what can be done (i.e.,

coping) to manage the stressors and/or the emotions that may result from them (i.e., secondary appraisal). Another of these models is the path model of chronic disease, metabolic syndrome and coronary heart disease of Vitaliano et al. (2002). Similar to Lazarus and Folkman's model, this model, emphasizes the importance of the controlling health habits when analyzing the relationship between caregivers' distress and cardiovascular diseases. In the context of caregiving, stressors can occur on a daily basis over a lengthy period of time (McConaghy & Caltabiano, 2005; Ory & Hoffman III, 1999). As a result, the chronic stress of caregiving makes caregivers more likely than their non-caregiving peers to appraise stressors as beyond their personal control (Mausbach, Chattillion, Roepke, Patterson, & Grant, 2013).

Caregivers may employ a variety of effective coping strategies to reduce the emotional impact of caregiving-related stressors. One such strategy may be mindfulness. Mindfulness can be considered to be a trait, reflecting "a person's baseline or average mindfulness" (Siegling & Petrides, 2014), one's ability to self-regulate attention toward immediate experience(s), and an orientation of openness and acceptance of thoughts, feelings, and sensations (Bishop et al., 2004). However, it may be also considered a trainable ability that can be improved by practice (Brown & Ryan, 2003, Shapiro, Brown, Thoresen & Plante, 2011). Both forms of mindfulness (trait and coping) have been associated with cardiovascular outcomes. Trait mindfulness has been associated with lower BP (Tomfohr, Pung, Mills, & Edwards, 2014) and mindfulness-based stress reduction programs have been shown to reduce systolic and diastolic BP in individuals with prehypertension and stage I and II hypertension (Abbott et al., 2014).

Thus, it follows from the above literature that in the midst of increased stress exposure, caregivers with greater trait mindfulness may be at reduced risk for elevated BP relative to those with reduced trait mindfulness. To our knowledge, the moderating effect of

mindfulness on the relationship between caregiving stress and BP has not previously been examined.

The aim of this study was to test the moderating role of trait mindfulness on the relationship between caregiving stress (i.e., frequency of care-recipients' disruptive behaviors) and BP in dementia caregivers. We hypothesized that trait mindfulness would moderate the relationship between frequency of disruptive behaviors of the care recipient and BP. Specifically, we hypothesized that those caregivers with a lower level of trait mindfulness would show a stronger relationship between frequency of disruptive behaviors and BP than those caregivers with a higher level of mindfulness. This finding would suggest that a higher level of trait mindfulness may be protective against high levels of stressors, in terms of cardiovascular health.

METHODS

Participants and Procedures

Participants were 110 family caregivers of either a parent or a spouse with dementia. Inclusion criteria were: a) being the principal caregiver of a relative with dementia, b) being 18 years or older, c) devoting an average of at least one daily hour to caregiving tasks, and d) providing care for at least 3 consecutive months. Caregivers with severe hypertension (>200/120 mmHg) were excluded from the study. Caregivers were contacted through health and social services and adult day services. All caregivers were face to face interviewed and provided written informed consent. The Ethics Committee of Rey Juan Carlos University and the Spanish Ministry of Economy and Competitiveness approved the study protocol.

Measures and Analyses

Demographic data and health characteristics. Demographic information collected included caregiver's age and gender. Body mass index (BMI), current smoking status, alcohol

consumption (days per week), physical exercise (days per week) and use of antihypertensive and statin medications were also collected.

Blood Pressure. An electronic sphygmomanometer OMROM M7 (HEM-780-E) was used for measuring resting BP. Three measures of systolic and diastolic BP were taken: at the beginning, in the middle and at the end of the interview.

Frequency of disruptive behaviors. The sub-scale of frequency of disruptive behaviors of the Revised Memory and Behavior Problems Checklist (RMBPC, Teri et al., 1992) was used. Eight items (i.e., "destroying property") are rated on a 5-point Likert scale between 0 ("never occurs") and 4 ("occurs daily or more often "). Cronbach's alpha for this subscale was .61 in the present study; similar to the .67 reported in the Teri et al. (1992) study.

Mindfulness. The Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003) was used for assessing caregivers' levels of trait mindfulness, as the presence or absence of attention to and awareness of what is occurring in the present. The MAAS is a 15 item scale (i.e., "I could be experiencing some emotion and not be conscious of it until sometime later") with each item having a response range between 1 ("almost always") to 6 ("almost never"). Cronbach's alpha for this scale was .82 in the present study.

Statistical analyses. Following Tabachnick & Fidell (2001) criteria, analyses for sample normality and outliers (univariate and multivariate) were conducted. No univariate or multivariate (Mahalanobis' distance of $p < .001$) outliers were found. Additional regression assumptions were checked in order to make valid inferences. The residuals of the regression were approximately normal in both regressions (all standardized residuals between the range -3 – 3 and Kolmogorov-Smirnov was non-significant in both regressions). Also, the residuals were homocedastic. The partial scatter plots showed linear relationship between the predictors and dependent variables and we did not found multicollinearity problems (all tolerances statistics were above .70). Finally, Durbin-Watson was 2.094 for the diastolic BP

regression and 1.824 for the systolic BP regression, thus no autocorrelation between the residuals was found. Separate hierarchical regression analysis were conducted for systolic and diastolic BP, following the Baron & Kenny (1986) criteria. For each analysis, known predictors of cardiovascular risk, similar to those used before in studies aiming at caregivers' blood pressure or cardiovascular risk, were controlled: age (Harmell et al., 2011; Mausbach et al. 2007), gender (Harmell et al., 2011; Mausbach et al., 2007), BMI (Harmell et al., 2011), current smoker (Mausbach et al., 2007; von Känel et al., 2008), number of days/week drinking alcohol (Harmell et al., 2011, von Känel et al., 2008), number of days/week performing physical exercise (von Känel et al., 2008), and use of antihypertensive (Harmel et al., 2011, von Känel et al., 2008) or statin medication (von Känel et al., 2008). Also, frequency of disruptive behaviors and mindfulness were included on this first step. In the second step, we introduced the interaction between the frequency of disruptive behaviors and mindfulness. In order to reduce multicollinearity problems, we centered all the independent and moderator variables at their means (Holmbeck, 2002). To examine the nature of the relationship between frequency of disruptive behaviors and BP for caregivers with high (+1 SD) vs. low (-1 SD) mindfulness, an interpretation graphic was made with a separate regression for each group, following the procedure described by Holmbeck (2002). The analyses were conducted using SPSS v.22 with significance level at $p < .05$ (two-tailed). In addition, two regression analyses were conducted to complement and validate the results regarding the interaction effect, using Mplus v7 software. As the reliability of the RMBPC was .61 (and thus, approximately 39% of the observed variance is error variance), the same previous regression analyses were conducted using latent variables obtained using structural equation modeling procedures following Kline's methodology (Kline, 2011). An advantage of using latent variables instead of observed variables is the ability to estimate relationships between variables adjusting for measurement error (Brown, 2015, p.43). As the observed

variables are not perfectly reliable, estimates of the regression coefficients are often attenuated. To alleviate this problem the relationships between independent and dependent variables were reanalyzed using structural equations, validating the previous models (i.e., to see whether the previous significant coefficients were replicated). Thus, frequency of disruptive behaviors latent factor was estimated through its 8 items, the mindfulness latent factor was estimated through its 15 items, and the interaction between the two constructs was estimated from these two estimated factors.

Finally, to estimate post-hoc power we have used Satorra-Saris method (Satorra & Saris,1985) following Brown's example (2015, p381). In particular, we calculated the power of the interaction effect (i.e., the moderating role of trait mindfulness on the relationship between caregiving stress and BP) in the diastolic BP regression. To do this, we used a Montecarlo simulation using Mplus v7 software to simulate 500 files with a population model from the observed correlation matrix (N=110 that mimic the present study). Then, in each of the 500 files we constrained the interaction effect to be zero to misspecify a model and estimate the non-centrality parameter in the χ^2 distribution with 1 df.

RESULTS

Descriptive data of the sample is shown in Table 1.

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For the systolic BP regression, no significant main effects were found for frequency of disruptive behaviors or for mindfulness. In addition, no significant effect was found for the interaction between disruptive behaviors and mindfulness. In the final model (Table 2), significant effects were found only for age and alcohol consumption.

For diastolic BP, no significant main effects were found for frequency of disruptive

behaviors or for mindfulness. However, significant effects were found in the final model (Table 2) for BMI and for the interaction between frequency of disruptive behaviors and mindfulness. Results of post-hoc power analysis for this interaction effect indicated that we had a power of .701 (the non-centrality λ parameter calculated over the 500 replications was 6.17) that approximates relatively well to the benchmark proposed by Cohen of .80. The interaction explains a small, but significant, percentage of diastolic BP (3.3%) and suggest that the effect of disruptive behaviors on BP depends on the level of mindfulness. The direction of this moderator effect is illustrated in Figure 1. The disruptive behaviors slope predicting diastolic BP when mindfulness is low (-1SD) was positive and significantly different from zero (B = .409, p = .038), while the effect of disruptive behaviors on diastolic BP when mindfulness was high (+1SD) was not significant (B = -.254, p = .336). The difference between the two slopes (i.e., the interaction effect) was significant (Wald test (1) = 4.739, p = .029). In addition, during follow-up (exploratory) analyses we estimated a mean diastolic BP of 82.87 mmHg at low mindfulness (-1SD) and high disruptive behaviors (+1SD). The estimated mean diastolic BP was 78.27 mmHg at high mindfulness (+1SD) and high disruptive behaviors (+1SD). The estimated difference was marginally significant (D = 4.60, p=.068). The estimated diastolic BP differences between both groups increased to 16.60 mmHg ($p < .05$) when compared at ±2 SD of mindfulness and disruptive behaviors levels. As mentioned in the data analysis section, in order to estimate relationships between variables adjusting for measurement error, the same relationships that were tested in the previous regressions were tested through structural equation models, using latent variables. The interaction effect from latent variables was also statistically significant ($p = .012$) in diastolic BP and the interpretation of the model was the same than the one obtained with observed variables. In the systolic BP model a non-significant p-value for the interaction effect ($p = .070$) was found. Thus, the same conclusions were reached from both statistical procedures.

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DISCUSSION

Our study supports the hypotheses that trait mindfulness moderates the relationship between frequency of care recipient disruptive behaviors and BP in dementia caregivers: when mindfulness is low, stress seems to have a stronger association with diastolic BP than when mindfulness is high, suggesting a potential protective effect of higher levels of mindfulness over blood pressure. This moderating effect was not significant for systolic BP. This lack of finding in one of the BP measures may be explained by the fact that systolic BP rises throughout the aging process, whereas diastolic BP stabilizes or even decreases (Franklin et al. 1997). This fact has its reflection on the results, with a strong positive effect of age over systolic BP, explaining a high percentage of its variance, a result that was not found for diastolic BP. Further studies should elucidate if these effects remain significant when comparing younger versus older caregivers. Therefore, the results of this study suggest that high mindfulness may buffer the effects of behavior problems on diastolic BP in particular, a finding that could be of particular relevance for cardiovascular health in dementia caregivers.

The findings from our study should be interpreted with caution, considering the cross-sectional study design which prevents us from making causal inferences such that there might be a bi-directional relationship between mindfulness and BP. In addition, the percentage of variance of diastolic BP explained by the interaction between frequency of disruptive behaviors and mindfulness, although significant, was low. Also all the participants were volunteers, limiting the generalizability to the dementia caregiver population at large. In addition, the relatively high percentage of female caregivers (a finding usually observed in caregiver studies) may also limit the generalizability of our findings as sexes differ in BP

values across the life span (Sandberg & Ji, 2012). An additional limitation of our study is the variation in tasks and duties that are faced by each caregiver. Also, another potential limitation of the study was using frequency of disruptive behaviors as a measure of caregiver stress. This may limit the generalizability of the results to other stress measures, and other stressors. Another limitation of the study is the low reliability of the RMBPC scale, although it was similar to the one obtained at the original study. Finally, although 29.1% of the caregivers were hypertensive (i.e. systolic and/or diastolic BP > 140/90 mmHg), none of them was suffering from severe hypertension. Participants with these health problems were excluded, following previous studies on blood pressure and/or cardiovascular risk in caregivers (Harmell et al., 2011, von Känel et al. 2008, von Känel et al. 2012). This may limit the generalizability of our results to populations with clinically manifest CVD and those with severe hypertension.

Nonetheless, the results of this study have implications for interventions with caregivers. Specifically, they provide support to mindfulness-based interventions aimed at improving cardiovascular health in caregivers. As commented in the introduction, mindfulness may be conceived not only as a trait-like dispositional variable, but also as a trainable ability that can be improved through practice, such as that which is enhanced in mindfulness-based psychological interventions. In light of the results of the present study, training caregivers in mindfulness techniques might decrease the impact of disruptive behaviors of care recipients on caregivers' BP, and ultimately diminish or minimize adverse cardiovascular outcomes. In this regard, mindfulness practice has been found to have an effect on cardiovascular risk by reducing cortisol levels in general population (Jacobs et al., 2013). Also, a reduction in BP associated with participation in a Mindfulness-Based Stress Reduction (MBSR) has been found in women with cancer (Campbell, Labelle, Bacon, Faris, & Carlson, 2012; Carlson, Speca, Faris, & Patel, 2007), and teaching mindfulness to people with cancer and their

relatives has been related with decreased levels of IL-6 and cortisol (Lengacher et al. 2012). In dementia caregiving populations, Kor, Chien, Liu and Lai (2017) conducted a meta-analysis finding that, as compared to control groups, mindfulness-based intervention groups significantly improve overall mental health by reducing stress and depressive symptoms, both of which have been associated with increased BP (Carroll, Ring, Hunt, Ford, & Macintyre, 2003; Nabi et al., 2011). Adding mindfulness training to interventions targeting care-recipients disruptive behaviors (e.g., Nogales-González, Losada, Márquez-González, & Zarit, 2014) may increase the clinical impact of these interventions on caregivers' health. Future studies should explore whether enhancement of mindfulness is able to significantly reduce BP and CVD risk in dementia caregivers.

Also, further studies should examine whether the autonomic and neuroendocrine mechanisms play a mechanistic role in the associations among disruptive behaviors, mindfulness and BP. For instance, previous studies have suggested that changes in cognitive mechanisms related to mindfulness (i.e., rumination, negative affect) could be associated with changes in cortisol levels (Jacobs et al., 2013) or BP (Campbell et al., 2012). Similarly, a recent study (Márquez-González, Cabrera, Losada & Knight, 2018) suggested that experiential avoidance of caregiving-related emotional stimuli is related to higher Mean Arterial Pressure (MAP), which is the average blood pressure from systole through diastole (i.e., the cardiac cycle). Such findings support the notion that mindfulness-related cognitive processes may underlie the moderating effect observed in our study.

In conclusion, this study found that high levels of mindfulness might moderate the relationship between dementia caregiving stress and cardiovascular health.

CLINICAL IMPLICATIONS:

- Mindfulness seems to be an important variable with potential for buffering the effects of caregiving stressors on caregivers' physical health, specifically in their diastolic blood pressure.

- Also, training caregivers in mindfulness may be helpful for reducing the impact of the behavioral and psychological symptoms of the dementia on caregivers' blood pressure, specifically their diastolic BP.

- Finally, as many studies support the efficacy of mindfulness-based therapies for improving caregivers' depressive and anxious symptoms (Brown, Coogle, & Wegelin, 2016; Epstein-Lubow, McBee, Darling, Armey, & Miller, 2011; Hou et al. 2014), this kind of interventions may also be useful and effective in order to reduce cardiovascular risk of caregivers.

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Tables and Figures

Table 1. Demographic data and health characteristics of 110 caregivers studied.

Variable	n (%)	M (SD)	Range
Age (years)		60.85 (12.43)	34-85
Gender (female)	87 (79.1)		
Body Mass Index (kg/m^2)		25.45 (3.86)	18.36 - 35.46
Current smoker (yes)	20 (18.2)		
Alcohol consumption (days/week)		1.93 (2.16)	0 - 6
Physical exercise (days/week)		1.97 (1.51)	0 - 4
Use of antihypertensives (yes)	24 (21.8)		
Use of statins (yes)	18 (16.4)		
Frequency of Disruptive Behaviors		7.72 (5.45)	0 - 21
Mindfulness		60.11 (14.08)	22 - 85

Table 2. Final models of the regressions on systolic and diastolic blood pressure

	Systolic blood pressure		Diastolic blood pressure	
	β	*p*	*β*	*p*
Age	.425	.000	.056	.576
Gender (0 = woman, 1 = man)	.002	.979	-.018	.858
Body mass index	.182	.053	.305	.003
Current smoker	-.055	.536	-.133	.162
Alcohol consumption	.173	.047	.093	.311
Days of exercise	.020	.819	-.050	.597
Use of antihypertensive medication	-.022	.818	.011	.910
Use of statin medication	.139	.133	.192	.051
Frequency of Disruptive Behaviors	.014	.882	.042	.679
Mindfulness	.017	.857	-.053	.597
Interaction (Frequency X Mindfulness)	-.142	.116	-.195	.043
R^2	.330		.244	
ΔR^2	.017		.033*	

*$p < .05$

Figure 1. Estimated relationship between frequency of disruptive behaviors and diastolic BP in caregivers with low (-1 SD) versus high (+1 SD) mindfulness.